1. Exposure Data

1.4 Occurrence and Exposure

1.4.1 Exposures

(a) Occupational exposure

Studies related to glyphosate exposure among workers include farmers and tree nursery workers in the US, forestry workers in Canada and Finland and municipal weed control workers in the UK (Acquavella *et al.*, 2004; Lavy et al., 1992; Centre de Toxicologie du Québec, 1988; Jauhiainen *et al.*, 1991; Johnson et al., 2005) (Table 1.4.1a)

Exposures to glyphosate have also been measured in farm families. Frequency of measurable exposure was small, with 4% and 12% of the spouses and children, respectively, showing detectable levels of exposures (Acquavella *et al.*, 2004).

(b) Community exposure

Glyphosate can be found in soil and water because of its use as an herbicide. (EPA, 1993). Once in the environment, glyphosate is adsorbed into soil and is broken by soil microbes to aminomethylphosphonic acid (AMPA) (Borggaard & Gimsing, 2008)

(i) Air

Very few studies of glyphosate in air were available. Air and rain samples were collected during at two growing seasons in agricultural areas in Indiana, Mississippi and Iowa, USA. The glyphosate concentration ranged from < 0.01 to 9.1 ng/m^3 in air samples and from < 0.01 to 2.5 in rain samples. The frequency of glyphosate detection ranged from 60 to 100% in both air and rain samples (Chang *et al.*, 2011). In Alberta, Canada, atmospheric deposition was measured at three sites in Eastern Central part of the province. Rainfall and particulate matter were collected as total deposition at seven-day intervals throughout the growing season. Glyphosate deposition rates ranged from < 0.001 to 1.51 μg/m^2/day (Humphries *et al.*, 2005). No data were available regarding glyphosate concentrations in indoor air.

(ii) Water

Glyphosate in the soil can leach into groundwater, (Borggaard & Gimsing, 2008) and it can also be washed directly into drains and surface waters (Simonsen *et al.*, 2008). Table 1.4.1b summarizes some recent data on concentrations of glyphosate or AMPA in surface water and groundwater. The maximum glyphosate concentration reported was 8.7 mg/L. The maximum concentration of AMPA recorded was 3.67 mg/L (Battaglin *et al.*, 2005).

(iii) Residues in food and dietary intake

Glyphosate residues have been measured in cereals, fruits and vegetables. Residues were detected in 50% of cereals, in Denmark in 2001a 9% in the European Union in 2009 (**Table 1.4.1c**). In the United Kingdom, food sampling for residues of glyphosate has concentrated mainly on cereals, including bread and flour. Glyphosate has been detected regularly and usually below the reporting limit (Pesticides Residues Committee, 2007, 2008, 2009, 2010). Six of eight samples of pieces of tofu (soy from Brazil) containing glyphosate with the highest level registered, 1.1 mg/kg (Pesticides Residues Committee, 2007).

(iv) Household exposure

In a survey of 246 California households, 14% were found to have at least one product containing glyphosate (Guha et al., 2013).

(v) Biological markers

Glyphosate concentrations in urine were analysed in urban populations in a Canadian and an European study (Aris & Leblanc, 2011; MLHB, 2013), and, in a rural population in Colombia (Aris & Leblanc, 2011; Varona *et al.*, 2009). Glyphosate concentrations were similar in Canadian and Colombian studies: 93.6 ng/ml and 130 µn/ml respectively (Varona *et al.*, 2009) but considerable higher than European 1.8 ng/ml (MLHB, 2013) (Table 1.4.1d).

1.4.2 Exposure assessment

Exposure assessment methods in epidemiologic studies of glyphosate and cancer are discussed in Section 1.0.

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